IEC 60034-9

Edition 4.1 2007-07

CONSOLIDATED VERSION

VERSION CONSOLIDÉE

Rotating electrical machines – Part 9: Noise limits

Machines électriques tournantes – Partie 9: Limites de bruit

IEC 60034-9:2003+A1:2007

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.160

ISBN 2-8318-9087-X

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ROTATING ELECTRICAL MACHINES –

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60034-9 has been prepared by IEC technical committee 2: Rotating machinery.

This edition includes the following significant technical changes:

- this edition reduces the no-load noise limits for single-speed, cage-induction motors according to Table 2;
- it also provides informative guidance on
  - the measurement surface to be used during some tests,
  - a method for the determination of an average sound pressure level,
  - an indication of "uncertainty" based upon the category of test procedure.

This consolidated version of IEC 60034-9 consists of the fourth edition (2003) [documents 2/1256/FDIS and 2/1272/RVD] and its amendment 1 (2007) [documents 2/1383/CDV and 2/1413/RVC].

The technical content is therefore identical to the base edition and its amendment(s) and has been prepared for user convenience.

It bears the edition number 4.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

Acoustic quantities can be expressed in sound pressure terms or sound power terms. The use of a sound power level, which can be specified independently of the measurement surface and environmental conditions, avoids the complications associated with sound pressure levels, which require additional data to be specified. Sound power levels provide a measure of radiated energy and have advantages in acoustic analysis and design.

ROTATING ELECTRICAL MACHINES –

Part 9: Noise limits

1 Scope

This part of IEC 60034:

– specifies test methods for the determination of sound power level of rotating electrical machines;

– specifies maximum A-weighted sound power levels for factory acceptance testing of network-supplied, rotating electrical machines in accordance with IEC 60034-1, having methods of cooling according to IEC 60034-6 and degrees of protection according to IEC 60034-5, and having the following characteristics:

- standard design, either a.c. or d.c., without additional special electrical, mechanical, or acoustical modifications intended to reduce the sound power level;
- rated output from 1 kW (or kVA) up to and including 5 500 kW (or kVA);
- rated speed not greater than 3 750 min^{-1}.

– provides guidance for the determination of noise levels for a.c. cage induction motors supplied by converters.

Excluded are a.c. motors supplied by converters. For these conditions see IEC 60034-17 for guidance.

The object of this standard is to determine maximum A-weighted sound power levels, L_{WA} in decibels, dB, for airborne noise emitted by rotating electrical machines of standard design, as a function of power, speed and load, and to specify the method of measurement and the test conditions appropriate for the determination of the sound power level of the machines to provide a standardized evaluation of machine noise up to the maximum specified sound power levels. This standard does not provide correction for the existence of tonal characteristics.

Sound pressure levels at a distance from the machine may be required in some applications, such as hearing protection programs. Information is provided on such a procedure in Clause 8 based on a standardized test environment.

NOTE 1 This standard recognizes the economic reason for the availability of standard noise-level machines for use in non-critical areas or for use with supplementary means of noise attenuation.

NOTE 2 Where sound power levels lower than those specified in Tables 1 or 2 are required, these should be agreed between the manufacturer and the purchaser, as special electrical, mechanical, or acoustical design may involve additional measures.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60034-1, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60034-5, *Rotating electrical machines – Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) – Classification*

IEC 60034-6, *Rotating electrical machines – Part 6: Methods of cooling (IC Code)*

IEC 60034-17, *Rotating electrical machines – Part 17: Cage induction motors when fed from convertors – Application guide*

ISO 3741, *Acoustics – Determination of sound power levels of noise sources using sound pressure – Precision methods for reverberation rooms*

ISO 3743-1, *Acoustics – Determination of sound power levels of noise sources – Engineering methods for small, movable sources in reverberant fields – Part 1: Comparison method for hard-walled test rooms*

ISO 3743-2, *Acoustics – Determination of sound power levels of noise sources using sound pressure – Engineering methods for small, movable sources in reverberant fields – Part 2: Method for special reverberation test rooms*

ISO 3744: *Acoustics – Determination of sound power levels of noise sources using sound pressure – Engineering method in an essentially free field over a reflecting plane*

ISO 3745, *Acoustics – Determination of sound power levels of noise sources – Precision methods for anechoic and semi-anechoic rooms*

ISO 3746, *Acoustics – Determination of sound power levels of noise sources using sound pressure – Survey method using an enveloping measurement surface over a reflecting plane*

ISO 3747, *Acoustics – Determination of sound power levels of noise sources using sound pressure – Comparison method in situ*

ISO 4871, *Acoustics – Declaration and verification of noise emission values of machinery and equipment*

ISO 9614-1, *Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 1: Measurement at discrete points*

ISO 9614-2, *Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 2: Measurement by scanning*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in the standards listed in the normative references together with the following apply.

3.1
sound power level
L_W
ten times the logarithm to the base 10 of the ratio of the sound power radiated by the source under test to the reference sound power [W_o = 1 pW (10^{-12} W)] expressed in decibels

3.2
sound pressure level
L_p
ten times the logarithm to the base 10 of the ratio of the square of the sound pressure to the square of the reference sound pressure [P_o = 20 µPa (2×10^{-5} Pa)] expressed in decibels

4 Methods of measurement

4.1 Sound pressure level measurements and calculation of sound power level produced by the machine shall be made in accordance with ISO 3744, unless one of the alternative methods specified in 4.3 or 4.4 below applies.

NOTE It is recommended that the hemispherical method be used for machines with shaft height up to 180 mm and the parallelepiped method used for machines larger than 355 mm. Either method may be used for intermediate shaft heights.

4.2 The maximum sound power levels specified in Tables 1 and 2 or adjusted by Table 3, relate to measurements made in accordance with 4.1.

4.3 When appropriate, one of the methods of precision or engineering grade accuracy, such as the methods of ISO 3741, ISO 3743-1, ISO 3743-2, ISO 3745, ISO 9614-1 or ISO 9614-2, may be used to determine sound power levels.

4.4 The simpler but less accurate method specified in ISO 3746 or ISO 3747 may be used, especially when the environmental conditions required by ISO 3744 cannot be satisfied (for example, for large machines).

However, to prove compliance with this standard, unless a correction due to inaccuracy of the measurement has already been applied to the values determined by this method in accordance with ISO 3746 or ISO 3747, the levels of Tables 1 and 2 shall be decreased by 2 dB.

4.5 If testing under rated load conditions, the methods of ISO 9614 are preferred. However, other methods are allowed when the load machine and auxiliary equipment are acoustically isolated or located outside the test environment.

5 Test conditions

5.1 Machine mounting

5.1.1 Precautions

Care should be taken to minimize the transmission and the radiation of structure-borne noise from all mounting elements including the foundation. This can be achieved by the resilient mounting for smaller machines, however, larger machines can usually only be tested under rigid mounting conditions.

Machines tested under load conditions shall be rigidly mounted.

5.1.2 Resilient mounting

The natural frequency of the support system and the machine under test shall be lower than a quarter of the frequency corresponding to the lowest rotational speed of the machine.

The effective mass of the resilient support shall be not greater than one-tenth of that of the machine under test.

5.1.3 Rigid mounting

The machines shall be rigidly mounted to a surface with dimensions adequate for the machine type (for example by foot or flange fixed in accordance with the manufacturer's instructions). The machine shall not be subject to additional mounting stresses from incorrect shimming or fasteners.

5.2 Test operating conditions

The following test conditions shall apply:

a) The machine shall operate at rated voltage(s), rated frequency or rated speed(s) and with appropriate field current(s) (when applicable). These shall be measured with instruments of an accuracy of 1 % or better.

   1) The standard load condition shall be no-load, except for series wound motors.

   2) When required, the machine shall be operated at an agreed load condition.

b) Machines shall be tested in their operating position within their specified duty that generates the greatest noise.

c) For an a.c. motor, the waveform and the degree of unbalance of the supply system shall comply with the requirements of 6.2 of IEC 60034-1.

   NOTE Any increase of voltage (and current) waveform distortion and unbalance will result in an increase in noise.

d) A synchronous motor shall be run with excitation to obtain unity power factor or for large machines tested as a generator.

e) A generator shall be either run as a motor or driven at rated speed with excitation to obtain the rated voltage on open-circuit.

f) A machine suitable for more than one speed shall be evaluated over the operating speed range.

g) A motor intended to be reversible shall be operated in both directions unless no difference in sound power level is expected. A unidirectional motor shall be tested in its design direction.

6 Sound power level limits

Where a machine is tested under the conditions specified in Clause 5, the sound power level of the machine shall not exceed the relevant value(s) specified as follows:

a) A machine, other than those specified in b), operating at no-load shall be as specified in Table 1.

b) A single-speed three-phase cage induction motor with cooling classification IC01, IC11, IC21, IC411, IC511 or IC611, at 50 Hz or 60 Hz, and with rated output not less than 1,0 kW and not exceeding 1 000 kW:

   - operating at no-load shall be as specified in Table 2;
   - operating at rated load shall be the sum of the values established in Tables 2 and 3.

Converter-supplied a.c. machines are excluded from specified limits.

NOTE 1 The limits of Tables 1 and 2 recognize class 2 accuracy grade levels of measurement uncertainty and production variations.

NOTE 2 Sound power levels, under full-load condition, are normally higher than those at no-load. Generally, if ventilation noise is predominant the change may be small; but, if the electromagnetic noise is predominant the change may be significant.

NOTE 3 The limits are irrespective of the direction of rotation. A machine with a unidirectional ventilator is generally less noisy than one with a bi-directional ventilator. This effect is more significant for high speed machines, which may be designed for unidirectional operation only.

NOTE 4 For some machines, the limits in Table 1 may not apply for speeds below nominal speed. In such a case, or where the relationship between noise level and load is important, limits should be agreed between the manufacturer and the purchaser.

NOTE 5 For multispeed machines the values in the Table 1 apply.

7 Determination of noise increments caused by converter supply

Noise emissions of electromagnetic origin at the converter supply can be considered as the superposition of:

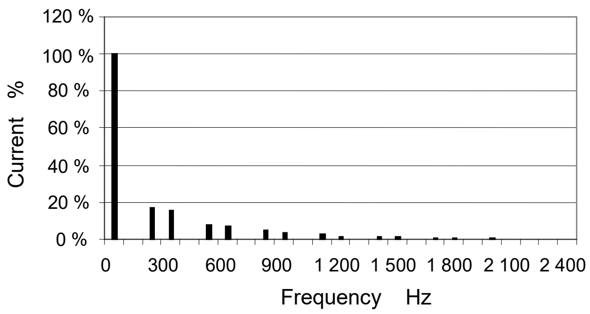
- the noise generated by the voltages and currents of fundamental frequency, which is identical with the noise at sinusoidal supply of the same values, and
- an increment caused by voltages and currents at other frequencies.

Two features mainly influence this increment:

a) The frequency spectrum at the converter terminals

Three typical frequency spectra can be identified:

1) Spectrum of a block-type current-source converter



Frequency spectrum of the currents at the output terminals of a 6-pulse current-source converter
f_1 = 50 Hz

IEC 337/07

2) Spectrum of type A voltage-source converter (characterized by pronounced spikes CLOSE to the switching frequency and its multiples)